

FINAL REPORT
APRIL 1996

REPORT NO. 96-10

PALLETIZED LOADING
SYSTEM (PLS) LOADED
TRUCK/TRAILER ON HTTX
FLATCAR RAIL IMPACT TEST

19970305 006

Prepared for:
Military Traffic Management Command-
Transportation Engineering Agency
ATTN: MTTE-DPE
Newport News, VA 23606-2574

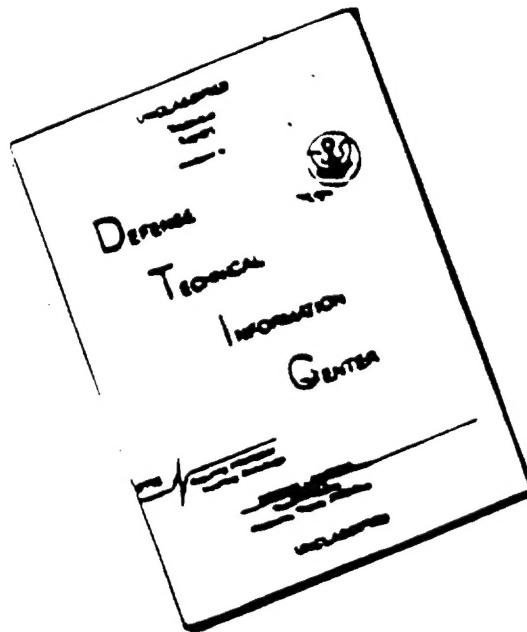
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<p>The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SIOAC-DEV), was tasked by Military Traffic Management Command-Transportation Engineering Agency (MTMC-TEA) to test a loaded Palletized Loading System (PLS) truck and loaded PLS trailer in a rail shipment configuration to satisfy transportation requirements of General Rule 15(g)8.2 on an HTTX or similar type flatcar. This requirement allows chain securement of the vehicles to the specially-equipped flatcar. These configurations were successfully tested at USADACS on 28 February 1996. This report contains results of the testing.</p>					
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22a. NAME OF RESPONSIBLE INDIVIDUAL JEROME H. KROHN			22b. TELEPHONE (Include Area Code) 815-273-8929		22c. OFFICE SYMBOL SIOAC-DEV

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639

REPORT NO. 96-10

PALLETIZED LOADING SYSTEM (PLS) LOADED TRUCK/TRAILER ON
HTTX FLATCAR RAIL IMPACT TESTING

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SIOAC-DEV), was tasked by the Military Traffic Management Command-Transportation Engineering Agency (MTMC-TEA) to test a loaded Palletized Loading System (PLS) truck and loaded PLS trailer in a rail shipment configuration to satisfy transportation requirements of General Rule 15(g)8.2 on an HTTX or similar type flatcars. This requirement allows chain securement of the vehicles to the specially-equipped flatcar. These configurations were successfully tested at USADACS on 28 February 1996.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL 61299-6000. Reference is made to Change 4, 4 October 1974, to AR-740-1, 23 April 1971, Storage and Supply Operations; AMCCOM-R 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. OBJECTIVE. The objective of these tests was to validate that the loaded PLS truck and trailer can be shipped on HTTX-type railcars equipped with chain securement fixtures IAW General Rule 15(g)8.2.

D. CONCLUSION. Both the PLS truck and PLS trailer were tested with an M1077 flatrack loaded to a gross weight of 38,450 pounds. The truck weighed 49,920 pounds and the trailer weighed 12,840 pounds. Each vehicle with the loaded flatrack was chained to an HTTX flatcar and impacted at 4, 6, 8.1 in the forward direction and 8.1 mph in reverse. During the test, vehicle brakes were released. Six chains were used to secure each end of the PLS truck with loaded flatrack to the HTTX flatcar. After two impacts in the rear direction, two of the six

chains securing the front end of the truck loosened up. During the third impact of 8.1 mph, in the rear direction, the two loose chains failed. The remaining four chains securing the forward end of the PLS truck remained intact. The loaded HTTX flatcar was turned and subjected to two additional impacts of 7.9 and 8.1 mph. During the last two impacts, the six chains securing the loaded PLS truck to the HTTX flatcar remained tight and held the truck in position.

The Association of American Railroad Manager observing this test stated that the test results were satisfactory.

E. RECOMMENDATION. Based on these tests, the PLS truck carrying a fully-loaded M1077 flatrack and a PLS trailer carrying a fully-loaded M1077 flatrack can be shipped on an HTTX flatcar equipped with chain securements as identified by the requirements of General Rule 15(g)8.2.

PART 2

28 FEBRUARY 1996

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PART 3

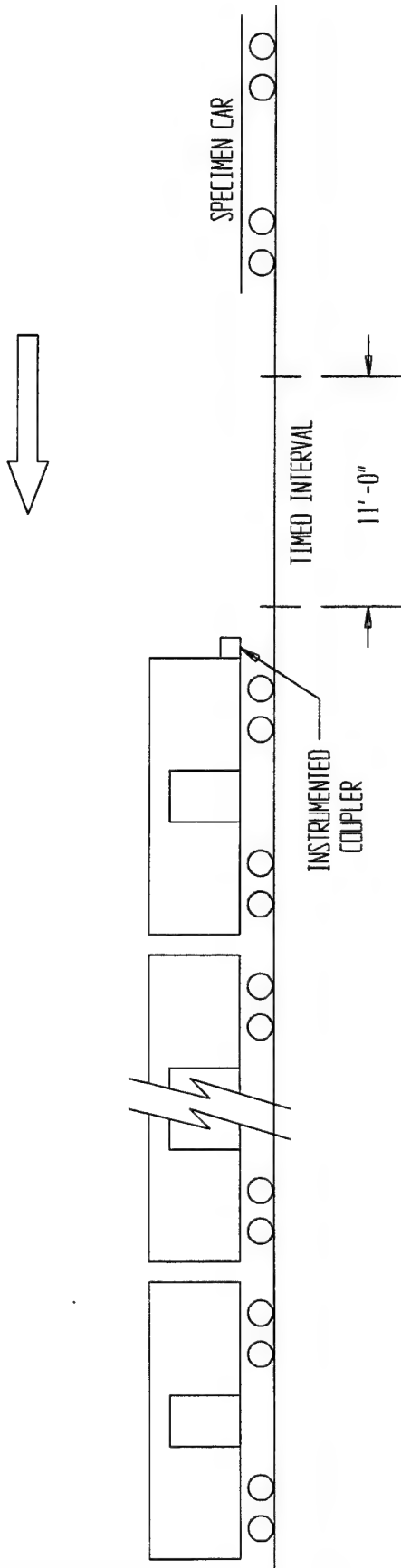
TEST PROCEDURES

A. These test procedures are extracted from TP-91-01, Transportability Testing Procedures, July 1991, for chassis-mounted container transportation by truck on railcar.

B. The PLS truck loaded with the M1077 flatrack and the PLS trailer loaded with the M1077 flatrack were each in turn loaded onto an HTTX flatcar and chained down. The PLS truck required six chains each on the front and rear. The PLS trailer required four chains each on the front and the rear. The M1077 flatrack was secured to the transporting vehicle with pins supplied with that vehicle.

C. RAIL IMPACT TEST. The M1077 flatrack was loaded on the PLS truck and trailer and positioned on an HTTX flatcar. Each vehicle in turn is secured to the HTTX flatcar with either 8 or 12 chains. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars were positioned on a level section of track with air and hand brakes set and with the draft gear compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars, then pushed the specimen car toward the anvil at a predetermined speed, then disconnected from the specimen car approximately 50 yards away from the anvil cars, which allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting is accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the reverse direction. The 4 and 6 mph impact speeds are approximate; the 8.1 mph speed is a minimum. Impact speeds were determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see Figure 1).

ASSOCIATION OF AMERICAN RAILROADS (AAR) STANDARD TEST PLAN



SPECIMEN CAR
IS RELEASED BY
SWITCH ENGINE TO
ATTAIN: IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH
THEN THE CAR IS REVERSED AND
RELEASED BY SWITCH ENGINE TO
ATTAIN: IMPACT NO 4. @ 8.1 MPH

5 BUFFER CARS (ANVIL) WITH DRAFT GEAR
COMPRESSED AND AIR BRAKES IN A SET
POSITION
ANVIL CARS TOTAL WT 250,000 LBS (APPROX)

FIGURE 1

D. This test sequence parallels the requirements outlined in the current edition of MIL-STD-810, rail impact testing. Speeds quoted in the standard are referenced to the metric measuring system and are currently converted to the English measuring system in paragraph C.

PART 4

TEST RESULTS

RAIL IMPACT DATA

TEST NO.: 1

DATE: 28 February 1996

SPECIMEN LOAD: Palletized Loading System (PLS) trailer with loaded M1077 flatrack secured to an HTTX rail flatcar with eight chains total.

FLATCAR: HTTX 90480

LT. WT.: 72,000 pounds

M1077 flatrack loaded with small arms

WT.: 38,450 pounds

PLS trailer

WT.: 12,840 pounds

TOTAL SPECIMEN WT.: 123,290 pounds

BUFFER CAR (FIVE CARS) WT.: 250,000 pounds

<u>IMPACT NO.</u>	<u>END STRUCK</u>	<u>VELOCITY (MPH)</u>	<u>REMARKS</u>
1	Rear	4.55	Ammunition load shifted on flatrack base 1/2-inch toward rear of pallet.
2	Rear	6.22	Load rear restraint boards bending.
3	Rear	N/A (8.6)	Load rear restraint boards warped at center. Movement from A-frame approximately 3/4-inch.
4	Forward	8.87	Load compressed against A-frame. Girth banding loosened to release protector clips.

RAIL IMPACT DATA

TEST NO.: 1

DATE: 28 February 1996

SPECIMEN LOAD: Palletized Loading System (PLS) truck with loaded M1077 flatrack secured to an HTTX railcar with 12 chains total.

FLATCAR: HTTX 90480

LT. WT.: 72,000 pounds

M1077 flatrack loaded with small arms

WT.: 38,450 pounds

PLS truck

WT.: 49,920 pounds

TOTAL SPECIMEN WT.: 160,370 pounds

BUFFER CAR (FIVE CARS) WT.: 250,000 pounds

<u>IMPACT NO.</u>	<u>END STRUCK</u>	<u>VELOCITY (MPH)</u>	<u>REMARKS</u>
1	Rear	4.51	No load shift.
2	Rear	6.23	One pair of chains loosened.
3	Rear	8.46	One pair of chains broken at front end of truck (opposite end of impact).
4	Forward	7.94	Speed too slow.
5	Forward	8.30	Test ammunition load remained intact. Chains at front of truck remained intact.

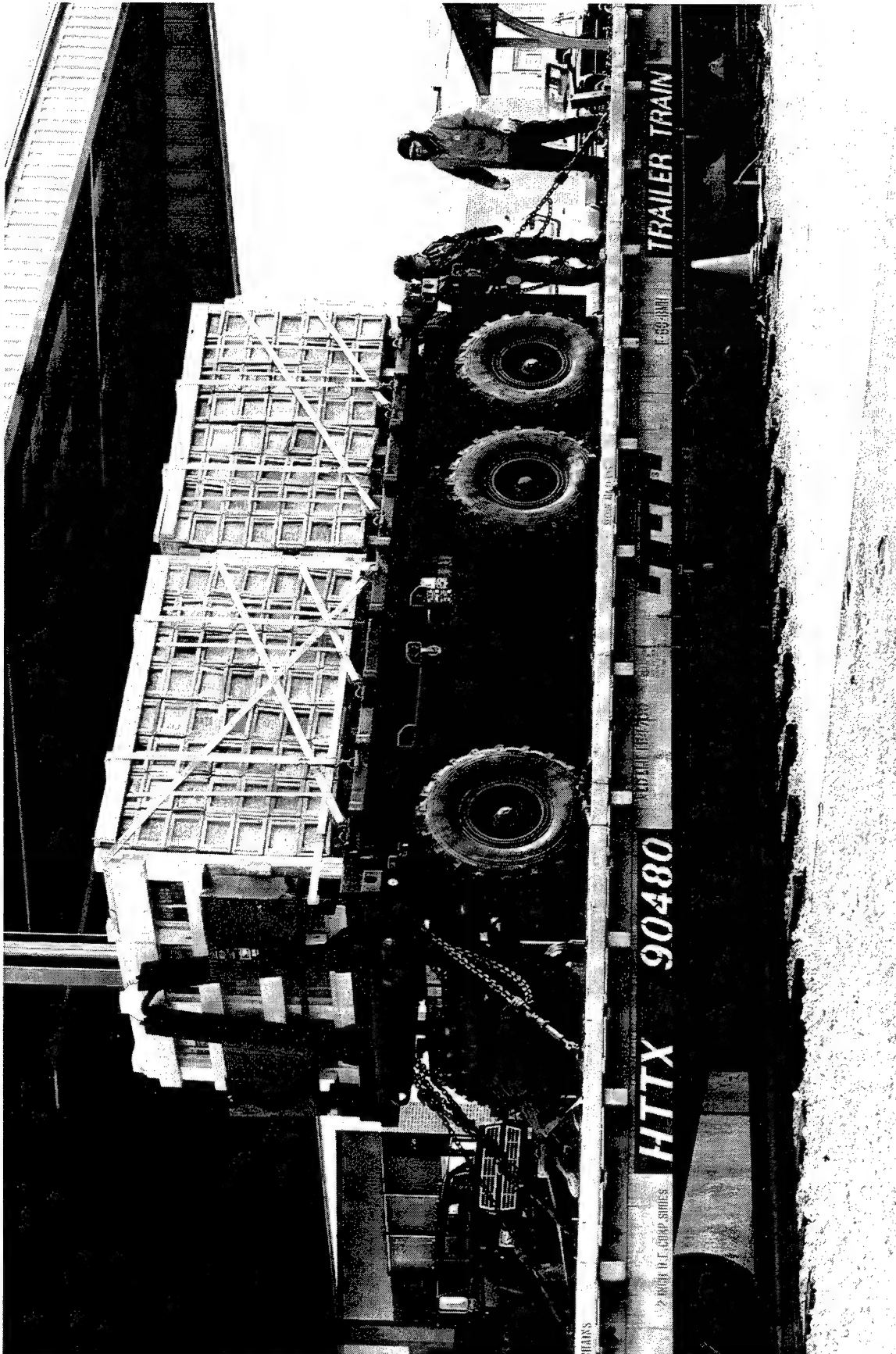
PART 5

PHOTOGRAPHS



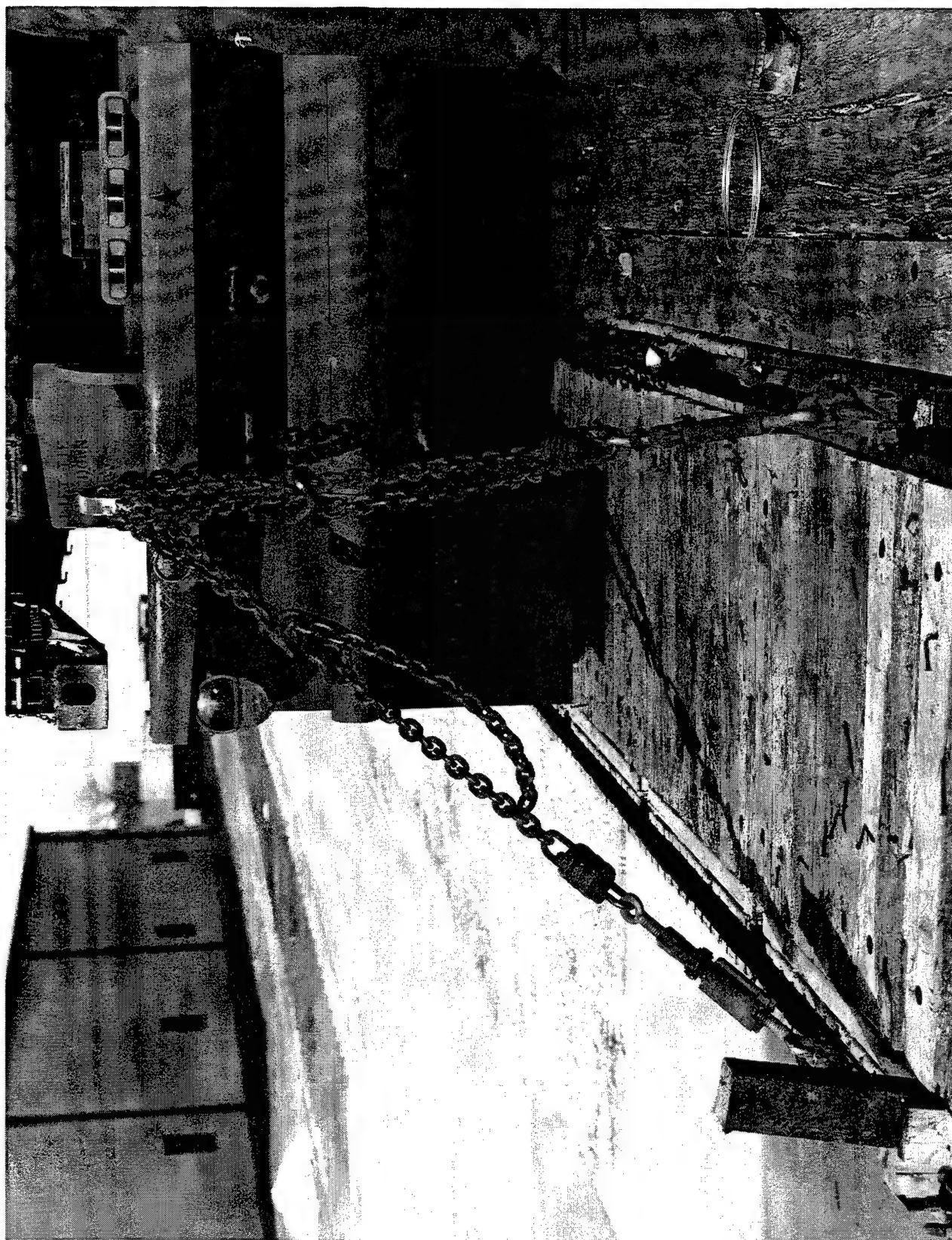
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SAVANNA, IL

Photo No. SCN-96-087-1732. This is a photo of the PLS trailer with a load of inert ammunition positioned for rail impact testing. The flatcar used for this test is an HTTX equipped with chains. Eight total chains were used to secure the loaded trailer to the flatcar.



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -
SAVANNA, IL

Photo No. SCN-96-087-1728. This is a photo of the PLS trailer with a load of inert ammunition positioned for rail impact testing. The flatcar used for this test is an HTTX equipped with chains. Eight total chains were used to secure the loaded trailer to the flatcar. Note the load is broken into two sections for better force distribution on the banding.



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. SCN-96-087-1733. This photo shows the chain positioning and connection between the PLS trailer and the HTTX flatcar. The other side of the trailer is identical.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. SCN-96-087-1734. This photo shows the chain positioning and connection between the PLS trailer and the HTTX flatcar. The trailer tongue was held down with a web strap.		



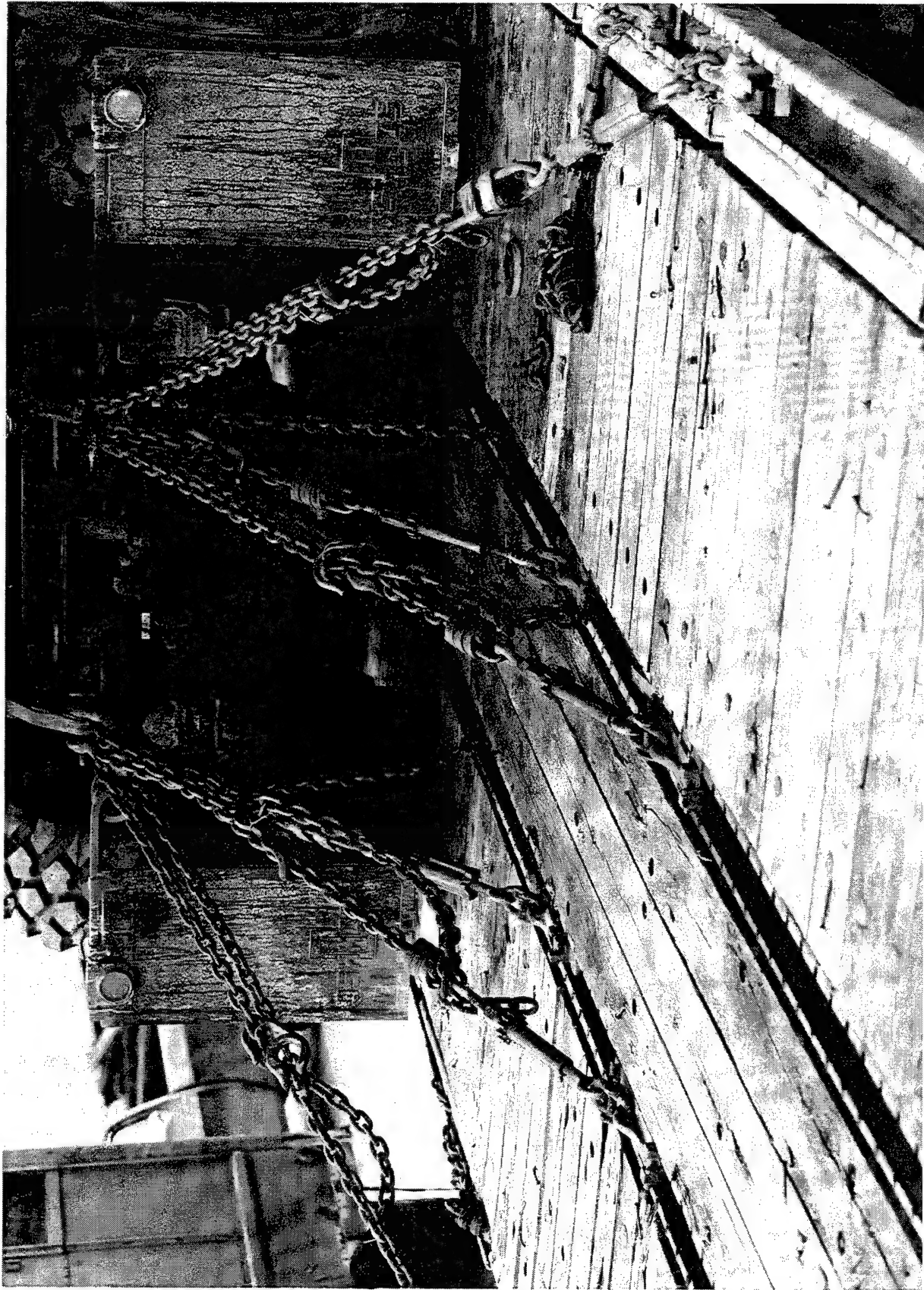


	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. SCN-96-87-1730. This photo shows a side view of the PLS truck chained to an HTTX flatcar. The truck is loaded with a flatrack of inert ammunition. The flatrack is pinned to the truck. Six rear chains hold the rear of the truck to the flatcar.		



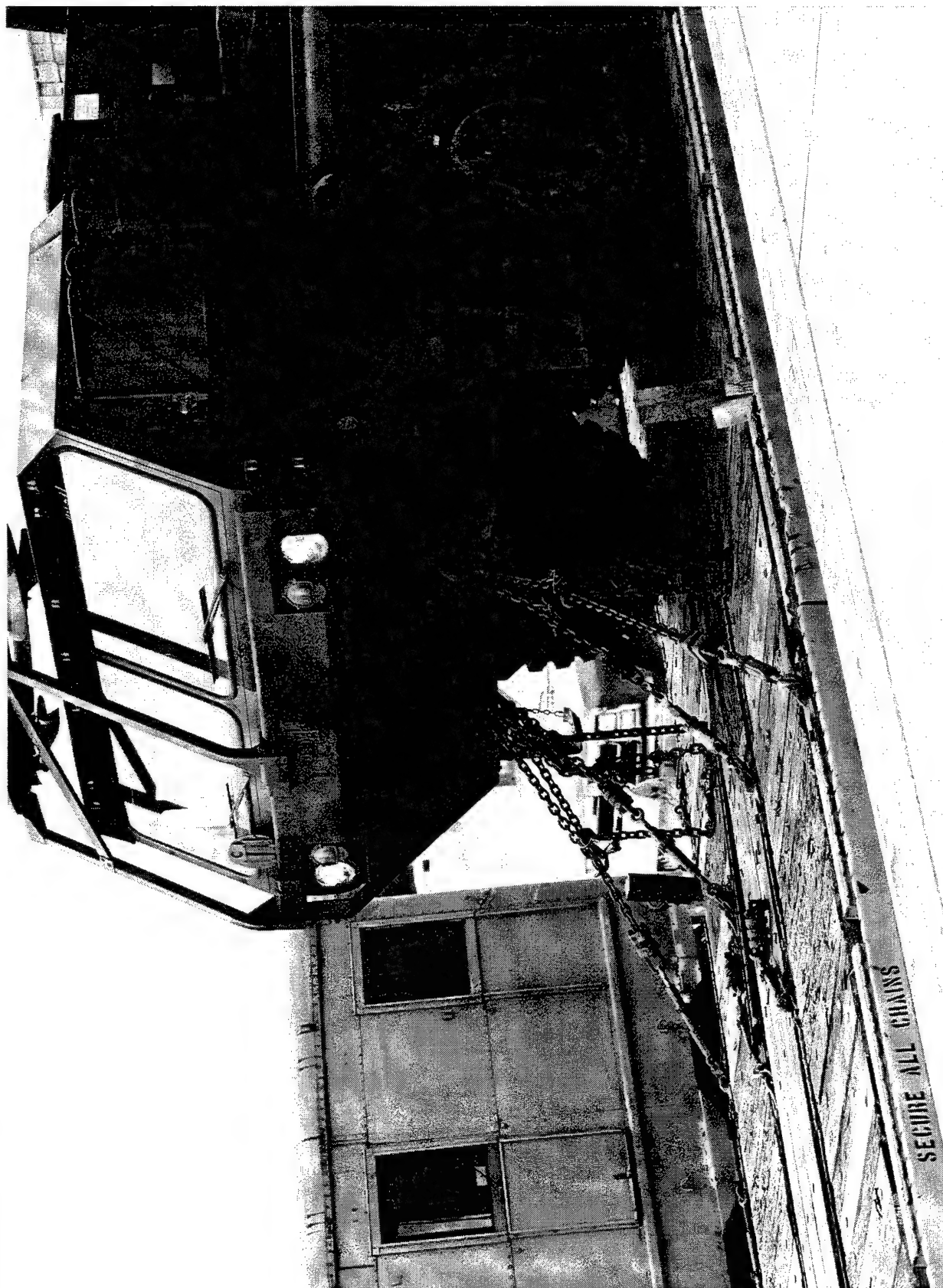
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SAVANNA, IL

Photo No. SCN-96-87-1729. This photo shows in detail the chains used to secure the PLS truck to an HTTX flatcar. Six chains are used with the hooks tied.

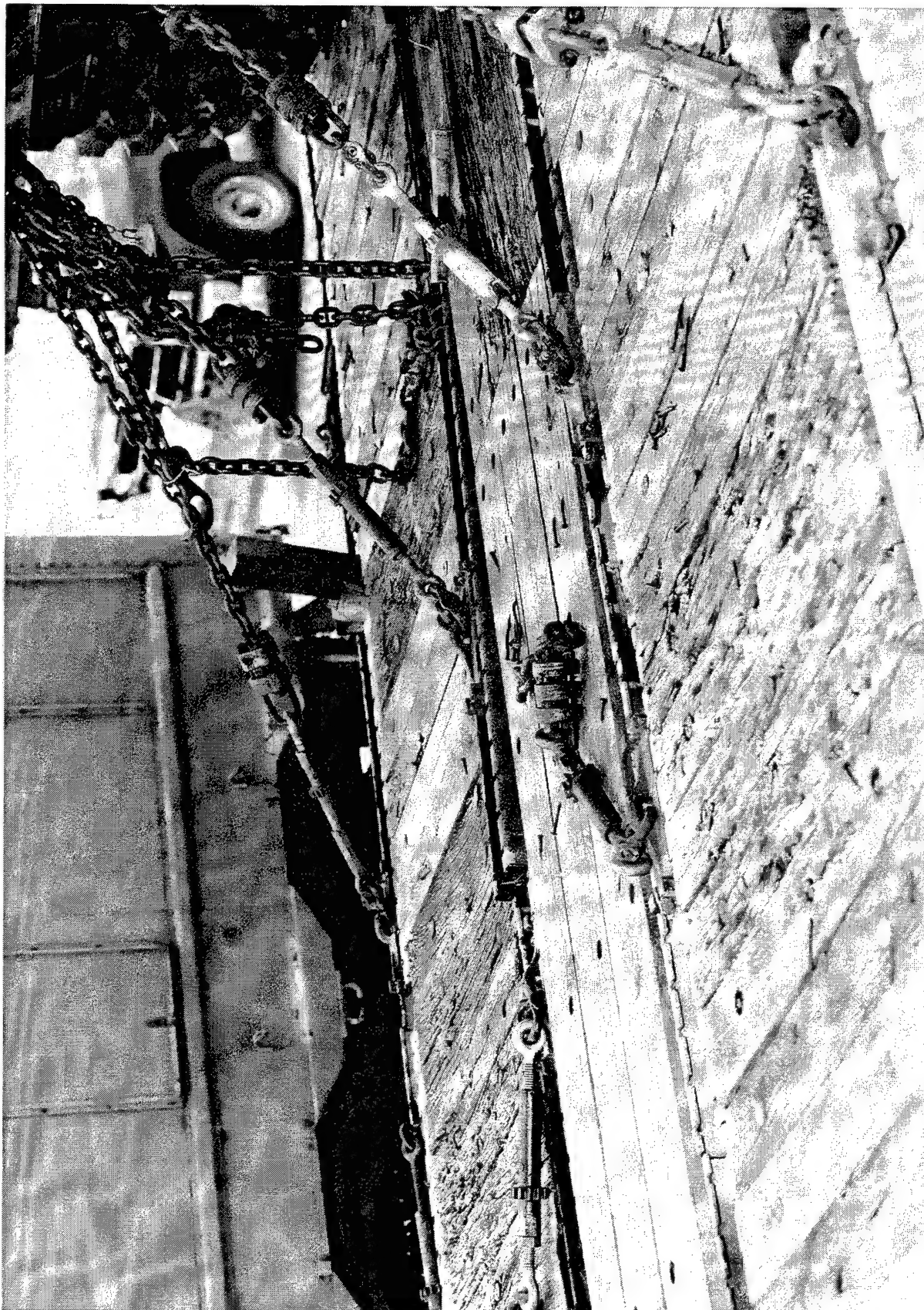


U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -
SAVANNA, IL

Photo No. SCN-96-87-1726. This photo shows in detail the chains used to secure the PLS truck to an HTTX flatcar. Six chains are used with the hooks tied.

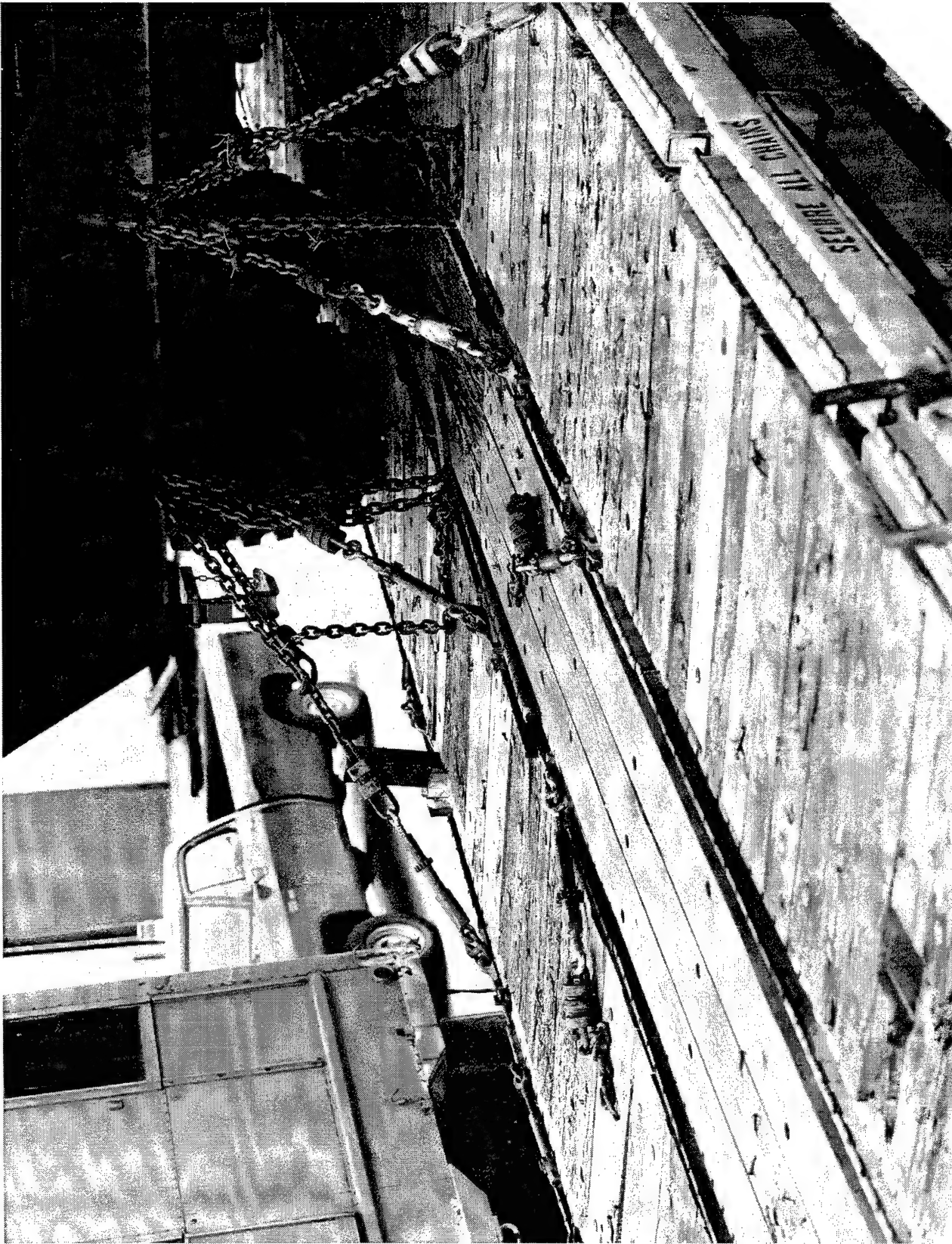


	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. SCN-96-87-1737. This photo shows the front end of the PLS truck after the 8.1 mph rearward impact. Note two chains are broken. The chains that broke were loosened after the 6 mph impact.		

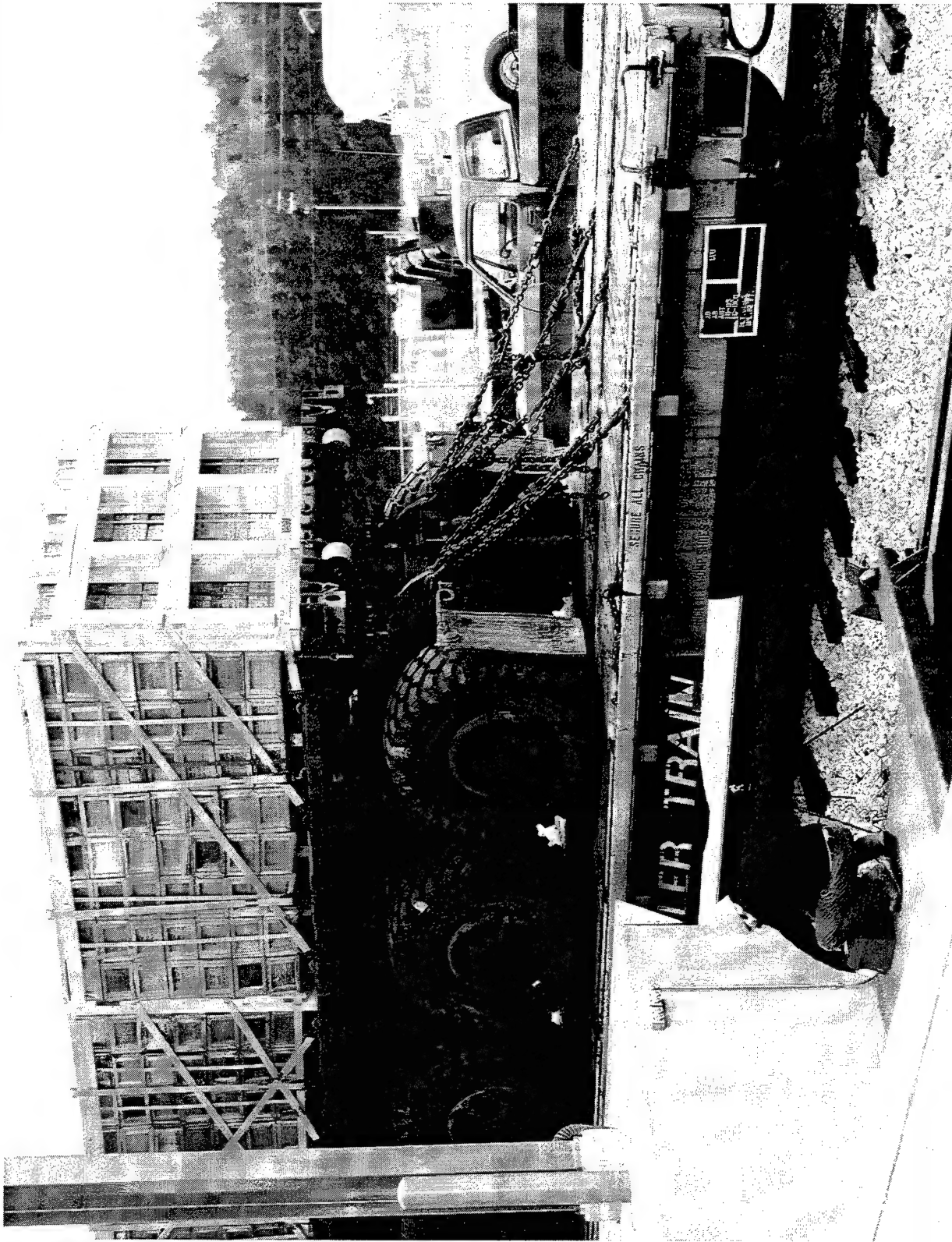


	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
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	Photo No. SCN-96-87-1741. This photo shows a closeup of the damage to the flatcar after the chains broke at the 8.1 mph impact. Note the chain securement rail pulling up from the car.	
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	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. SCN-96-87-1739. This photo shows the damage to the flatcar after the chains broke at the 8.1 mph impact. Note the chain securement rail pulling up from the car.		



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -
SAVANNA, IL

Photo No. SCN-96-87-1738. This photo shows the rear chains used to secure the PLS truck to the HTTX flatcar after the 8.1 mph reverse impact. All chains held the truck on the flatcar.

PART 6

DRAWING



REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY
MILITARY TRAFFIC MANAGEMENT COMMAND
TRANSPORTATION ENGINEERING AGENCY
720 THIMBLE SHOALS BOULEVARD, SUITE 130
NEWPORT NEWS, VIRGINIA 23606-2574



April 20, 1995

Deployability Engineering Team

Mr. Daniel L. Lowman
Manager, AAR Loading Rules
Association of American Railroads
50 F Street, N.W.
Washington, DC 20001

Dear Mr. Lowman:

Please consider the following enclosed figures for approval and publication in Section No. 6:

1. M1074/M1075 Palletized Load System (PLS) Truck, 88,000 lbs and Under - HTTX or Similar Type Flat Cars
2. M1076 Palletized Load System (PLS) Trailer, 49,600 lbs and Under - HTTX or Similar Type Flat Cars

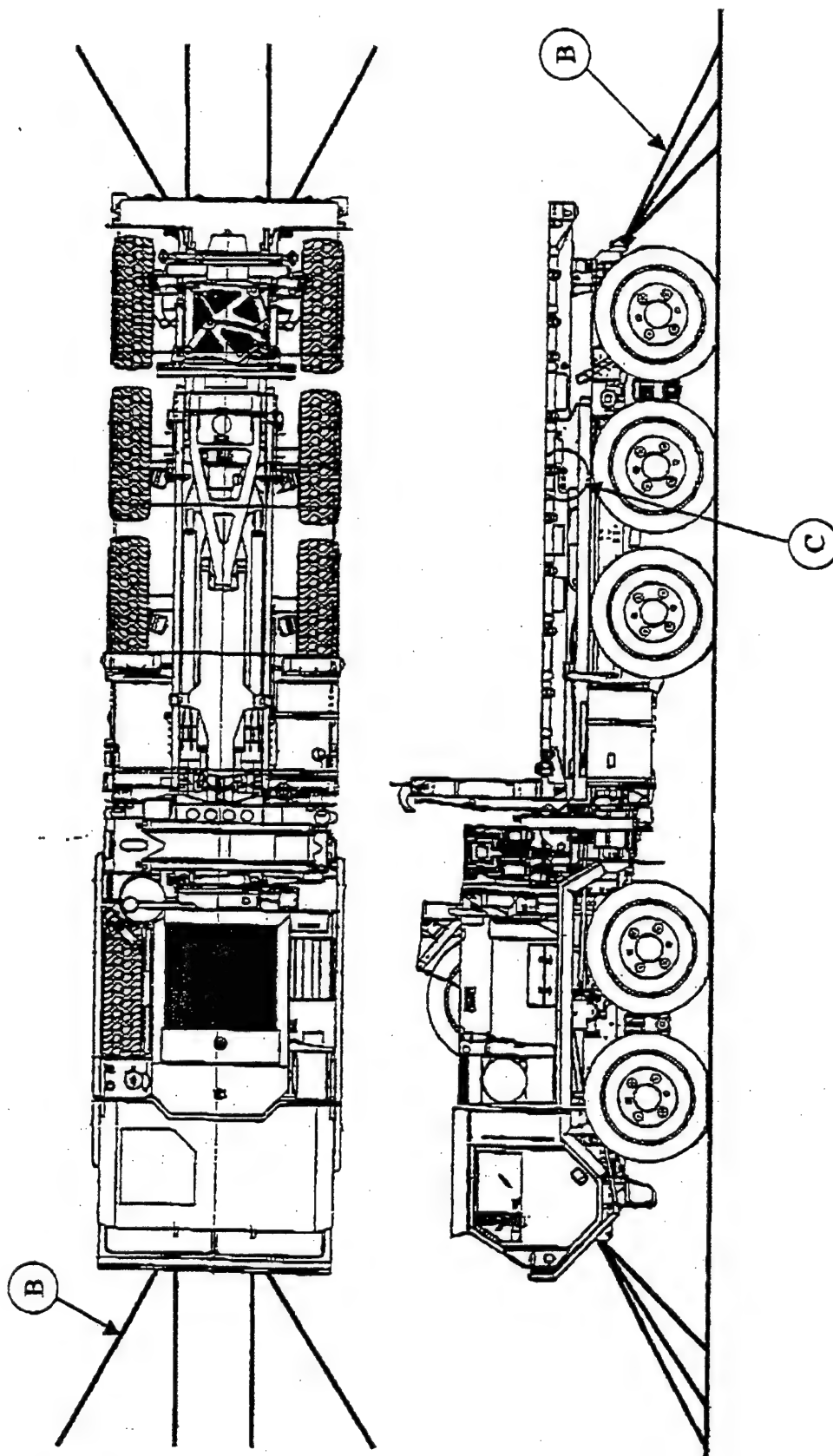
The HTTX has end-of-car cushioning and the number of chains is based on General Rule 15(g)8.2. Since these two figures are related to each other, we would have no objection to combining them into a single figure.

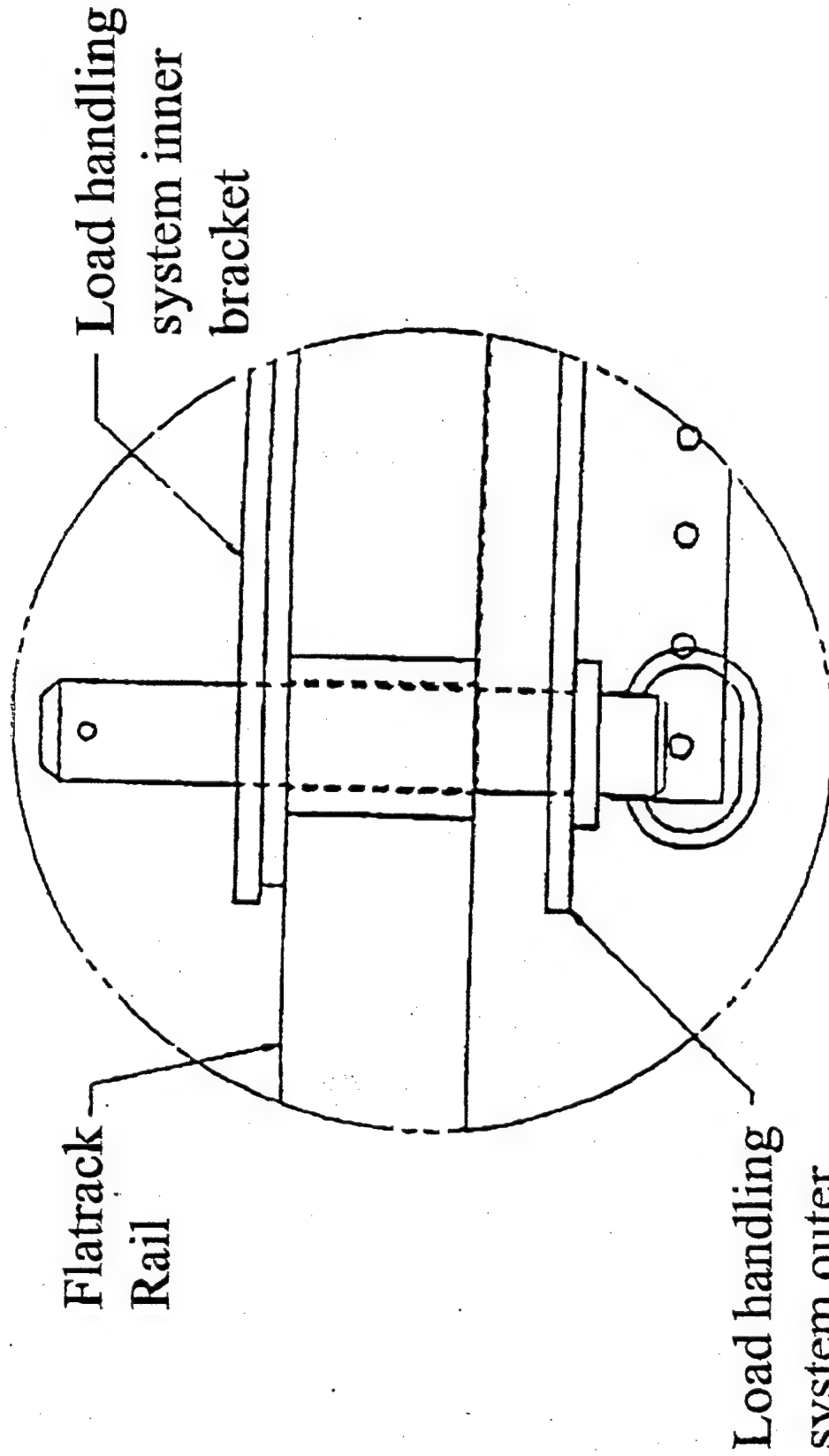
Sincerely,

ROBERT E. KERR, P.E.
DOD-AAR Representative

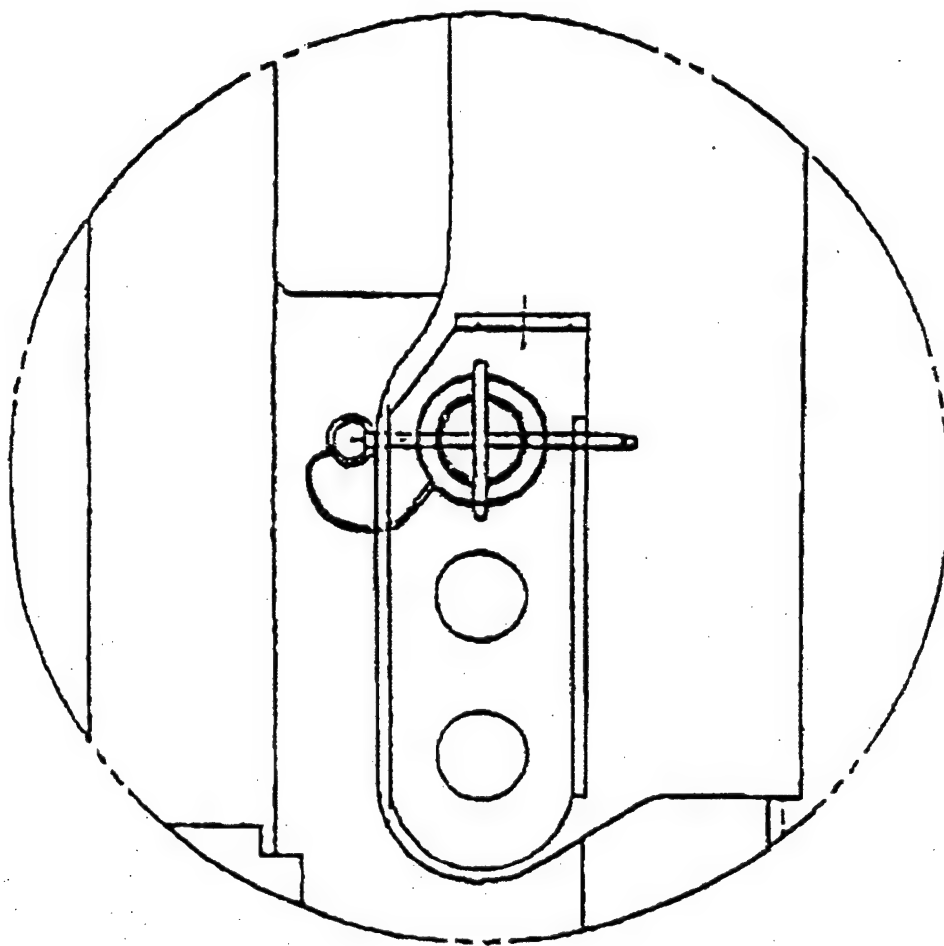
2 Enclosures
(16 copies each)

**M1074/M1075 PALLETIZED LOAD SYSTEM (PLS) TRUCK, 88,000 LBS.
AND UNDER - HTTX OR SIMILAR TYPE FLAT CARS**

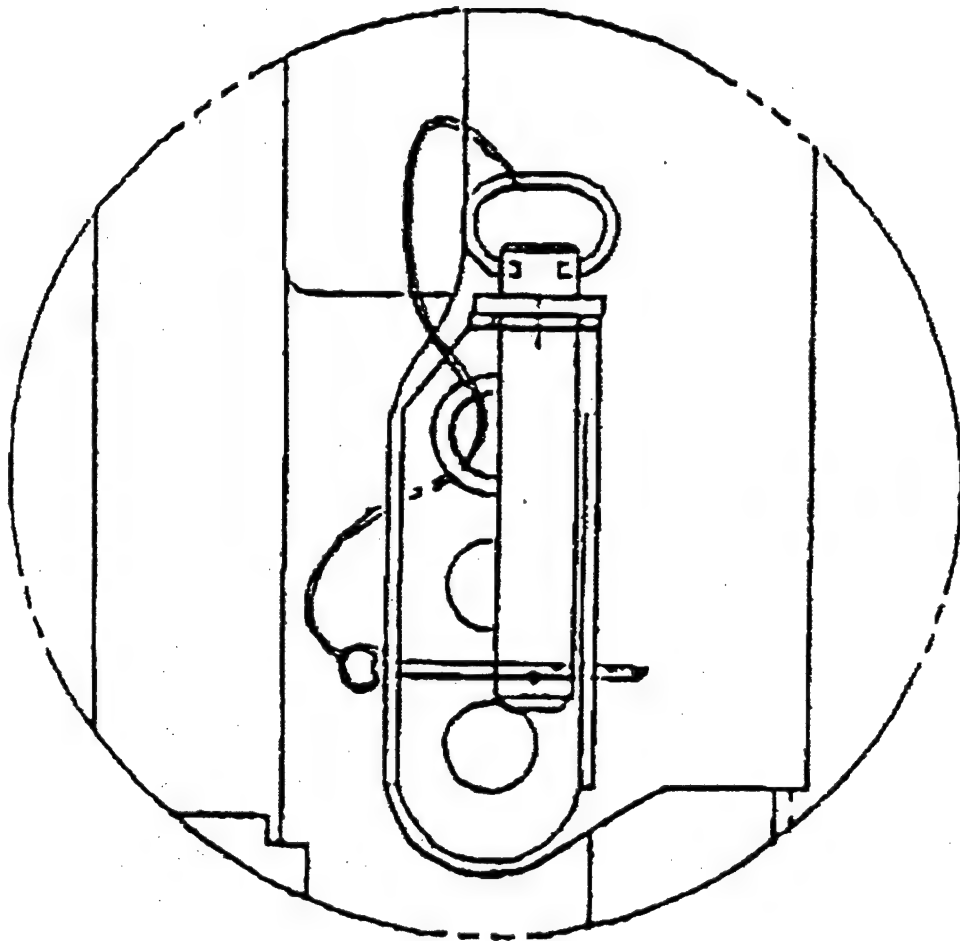




Sketch 1



Sketch 2



Sketch 3

**M1074/M1075 PALLETIZED LOAD SYSTEM (PLS) TRUCK, 88,000 LBS. AND
UNDER - HTTX OR SIMILAR TYPE FLAT CARS**

Item	No. of Pcs.	Description
A		Brake Wheel Clearance, See Fig 2, Sec. 1.
B	12 ea. unit	1/2 in. dia. alloy steel chain, proof tested to minimum of 27,500 lbs., for PLS trucks weighing over 49,500 lbs to 82,000 lbs., inclusive.
	16 ea. unit	1/2 in. dia. alloy steel chain, proof tested to minimum of 27,500 lbs., for PLS trucks weighing over 82,000 lbs to 88,000 lbs., inclusive.
C	2 ea. unit	Flatrack securing pin in rail transport position (top view), see sketch 1. Flatrack securing pin in rail transport position (side view), see sketch 2. Flatrack securing pin shown in stowed position, see sketch 3. Install the two pins (one on each side) to secure the flatrack to the truck for rail transport.

Notes:

1. Shippers should specify cars equipped with tie-down devices in the quantity shown in item "B" when ordering specialized railway equipment. When necessary to use cars that do not have built-in chains and tensioning devices, chains and turnbuckles of the appropriate size and strength may be used to secure the PLS truck.

2. Vehicles must face in the same direction and be uniformly spaced the length of car to allow sufficient space at each end of the car and between vehicles for securement. Apply tie-downs parallel to each other at the same end of the vehicle and from the vehicle tie-down point to the car tie-down facility. Angle of tie-downs must be as close to 45 degrees as possible.

3. Tiedown chains must be free from twisted or kinked links prior to their application to the vehicle.

4. Transmission shall be in neutral with the lever wired in place. Set the parking brake to prevent the vehicle from inadvertently moving during the securement and loading process.

5. Open hooks must be secured with wire over the opening to prevent the hook from becoming disengaged from the chain link to which it is secured.

**M1074/M1075 PALLETIZED LOAD SYSTEM (PLS) TRUCK, 88,000 LBS. AND
UNDER - HTTX OR SIMILAR TYPE FLAT CARS**

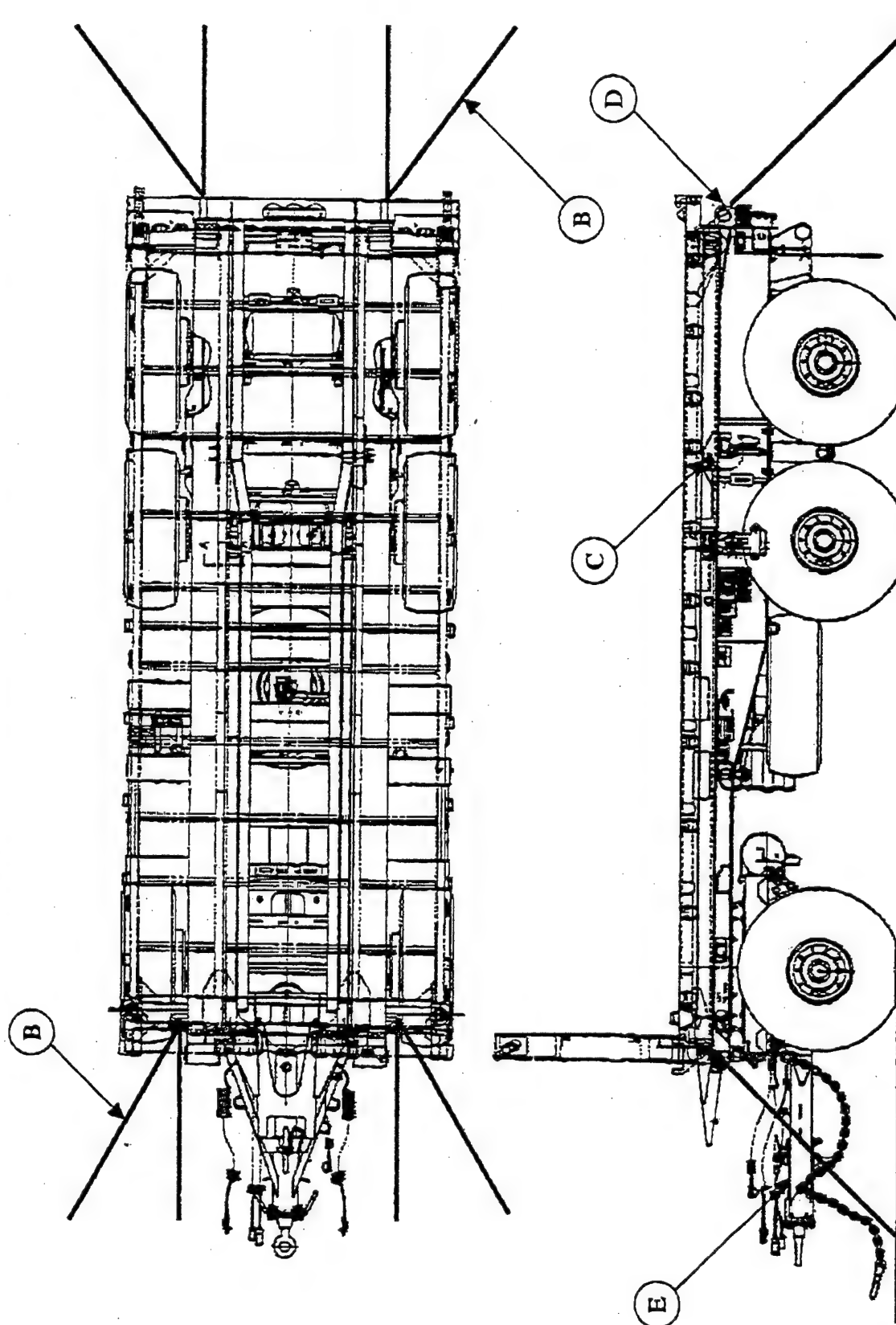
6. When the PLS truck is shipped in the loaded configuration, the gross weight of the vehicle and cargo combined must be determined in order to ensure that the proper number of tie-downs are used to secure the truck to the rail car.

7. Prior to securing the truck, attach PLS shackles to holes in tiedown provisions, four in the front and four in the rear.

8. The majority of the tie down chains should go to the center tie-down channels.

See General Rules 1, 2, 3, 4, 5, 7, 9, 11, 14, 15, 19, 19-A and 19-B for further details.

**M1076 PALLETIZED LOAD SYSTEM (PLS) TRAILER, 49,600 LBS. AND
UNDER - HTTX OR SIMILAR TYPE FLAT CARS**



M1076 PALLETIZED LOAD SYSTEM (PLS) TRAILER, 49,600 LBS. AND UNDER -
HTTX OR SIMILAR TYPE FLAT CARS

Item	No. of Pcs.	Description
A		Brake Wheel Clearance, See Fig 2, Sec. 1.
B	4 ea. unit	1/2 in. dia. alloy steel chain, proof tested to minimum of 27,500 lbs., for PLS trailers weighing over 16,500 lbs to 27,500 lbs., inclusive.
	8 ea. unit	1/2 in. dia. alloy steel chain, proof tested to minimum of 27,500 lbs., for PLS trailers weighing over 27,500 lbs to 49,600 lbs., inclusive.
C	2 ea. unit	Two removable plates (one on each side of the trailer) and two flatrack securing pins. Install the plates and pins to secure the flatrack to the trailer for rail transport.
D	1 ea. unit	Engage flatrack lock control valve.
E		Secure drawbar in shortest position. With drawbar raised horizontal, secure drawbar safety chain attachment point to bumper with one complete loop of 3/8" wire rope pulled snug, fastened with four clamps. If desired, drawbar may be lowered onto a piece of 2" lumber nailed to the deck. Secure drawbar down with two chains.

Notes:

1. Shippers should specify cars equipped with tie-down devices in the quantity shown in item "B" when ordering specialized railway equipment. When necessary to use cars that do not have built-in chains and tensioning devices, chains and turnbuckles of the appropriate size and strength may be used to secure the PLS trailer.

2. Vehicles must face in the same direction and be uniformly spaced the length of car to allow sufficient space at each end of the car and between vehicles for securement. Apply tie-downs parallel to each other at the same end of the vehicle and from the vehicle tie-down point to the car tie-down facility. Angle of tie-downs must be as close to 45 degrees as possible.

3. Tiedown chains must be free from twisted or kinked links prior to their application to the vehicle.

**M1076 PALLETIZED LOAD SYSTEM (PLS) TRAILER, 49,600 LBS. AND UNDER -
HTTX OR SIMILAR TYPE FLAT CARS**

4. Open hooks must be secured with wire over the opening to prevent the hook from becoming disengaged from the chain link to which it is secured.

5. When the PLS trailer is shipped in the loaded configuration, the gross weight of the vehicle and cargo combined must be determined in order to ensure that the proper number of tie-downs are used to secure the trailer to the rail car.

See General Rules 1, 2, 3, 4, 5, 7, 9, 11, 14, 15 and 19-B for further details.

PART 7

TEST DATA FROM UNION PACIFIC



UNION PACIFIC RAILROAD

FORM 25165 (Rev. 1-92)

RESEARCH AND DEVELOPMENT LABORATORY

PROJECT _____

SHEET NUMBER _____ OF _____ W.O. _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

FILE NUMBER _____

Flat Rack on Trailer

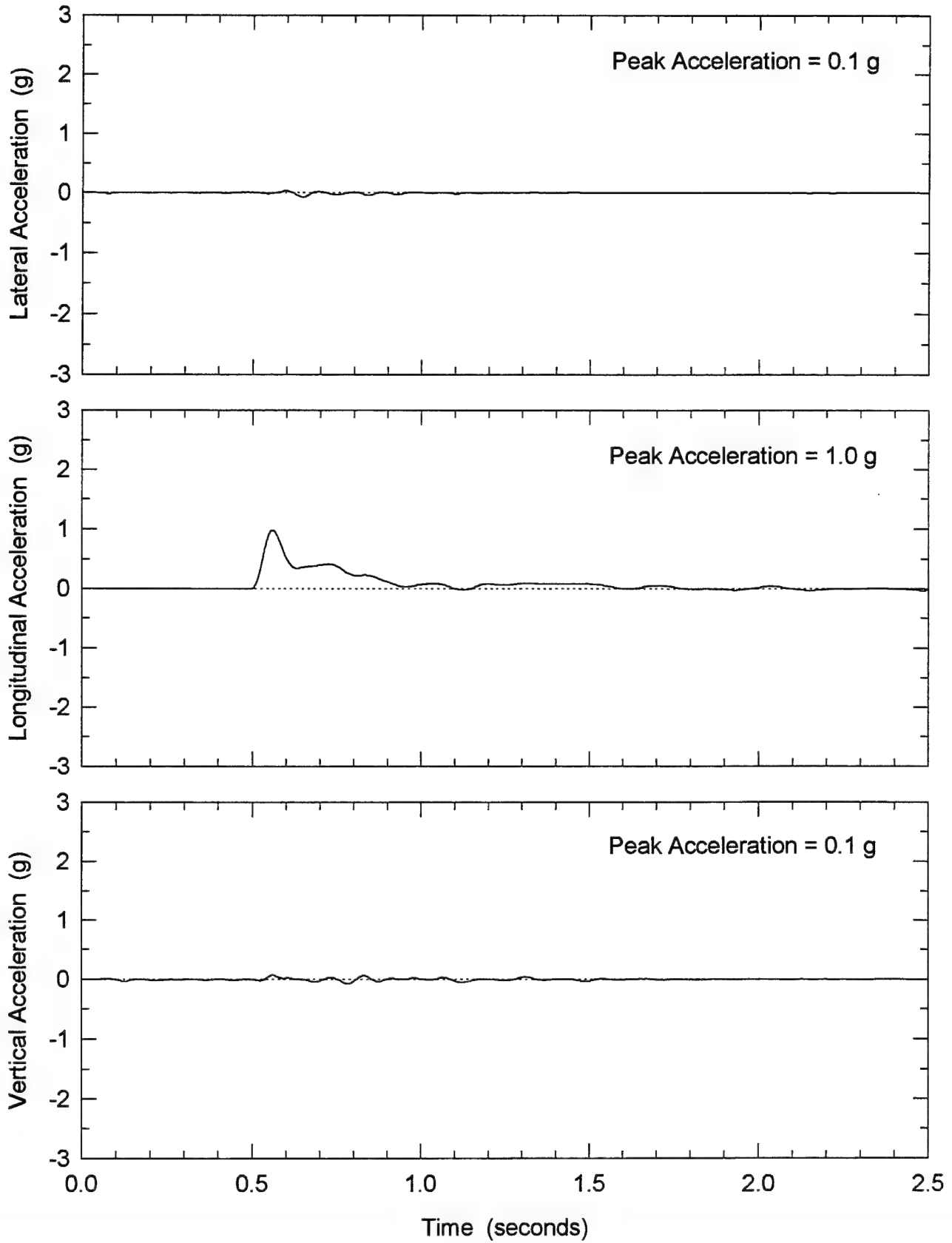
<u>Speed</u>	<u>Peak Acceleration</u>	
4.55	4.6 mph	1.0 g
6.22	6.3	1.9
NA	8.6	2.7
8.87	8.9	2.1
		- reverse

Flat Rack on Truck

<u>Speed</u>	<u>Peak Acceleration</u>	
4.51	4.5 mph	0.7 g
6.23	6.2	1.7
8.46	8.5	2.4
7.94	8.0 radar	2.7
8.30	8.3	2.8
		truck moving backward
		truck moving forward

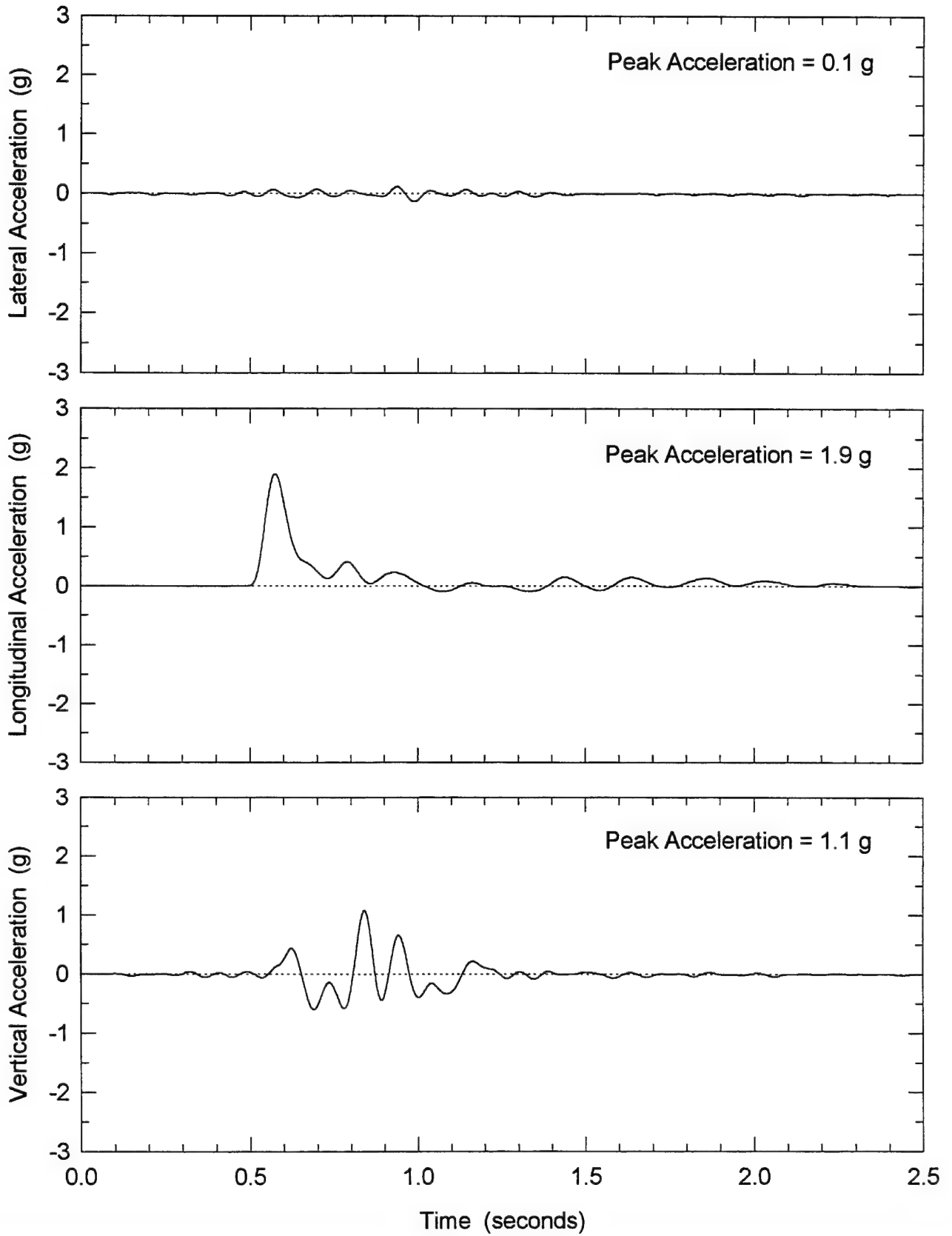
Pallet on Trailer

Coupling Speed = 4.6 mph



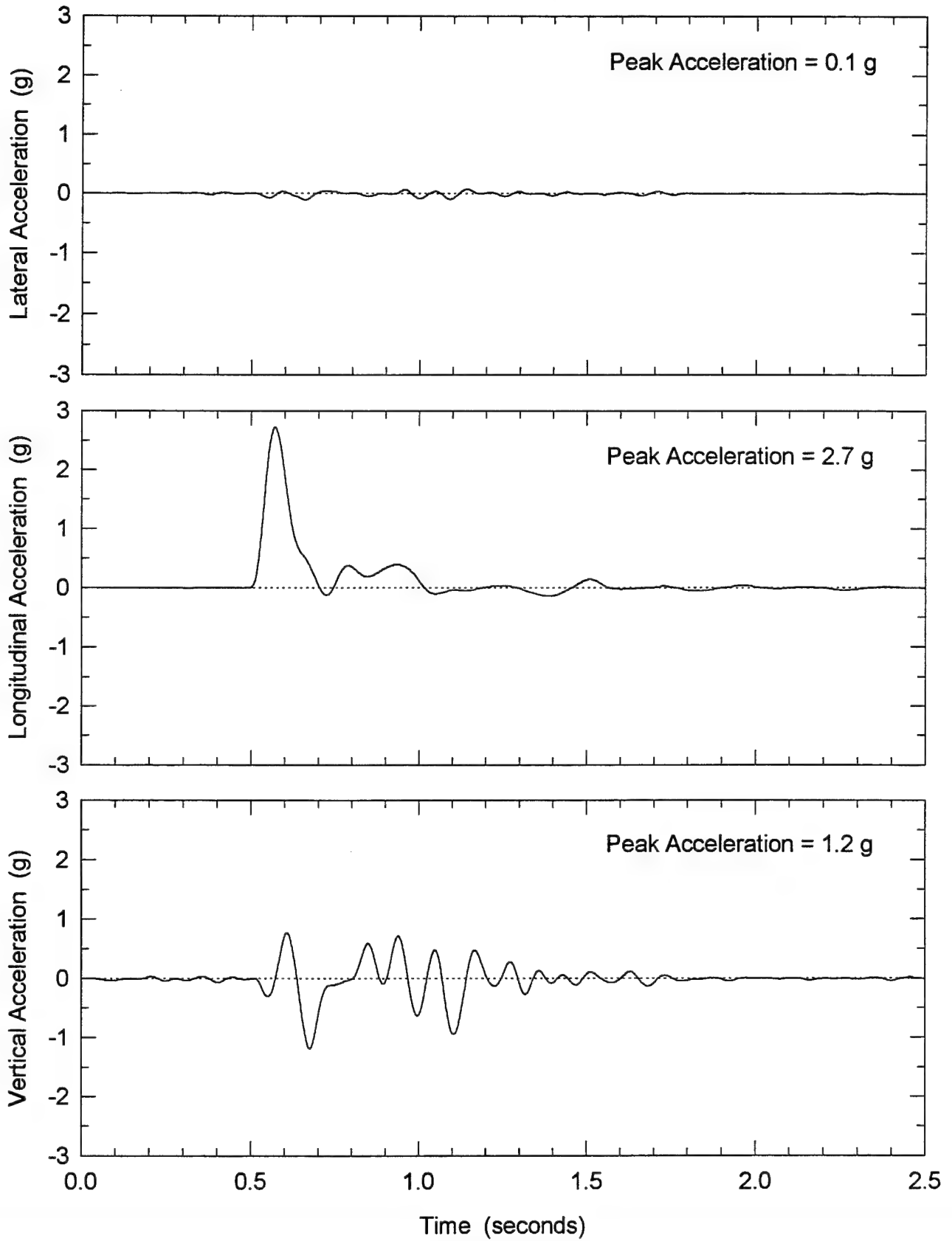
Pallet on Trailer

Coupling Speed = 6.3 mph



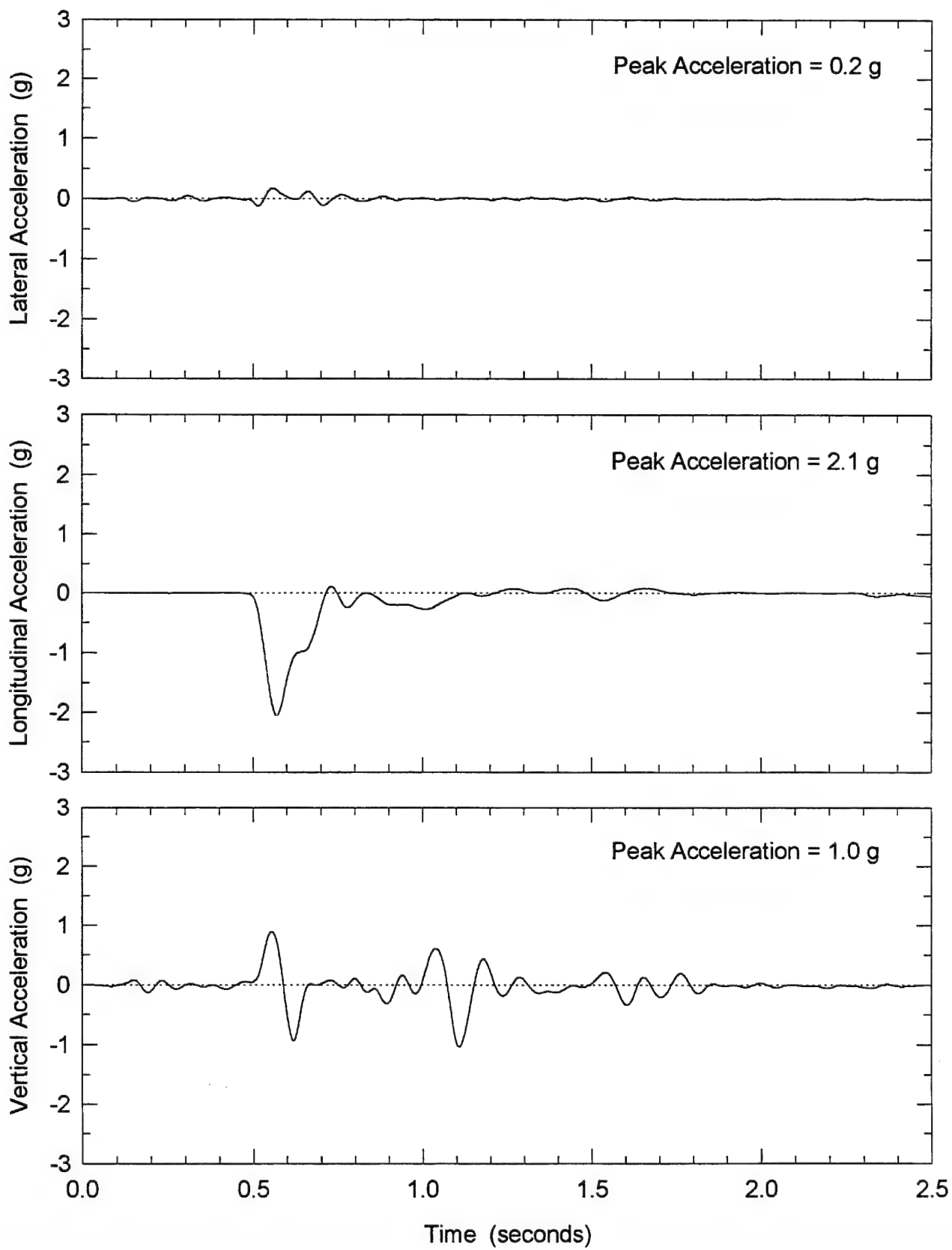
Pallet on Trailer

Coupling Speed = 8.6 mph



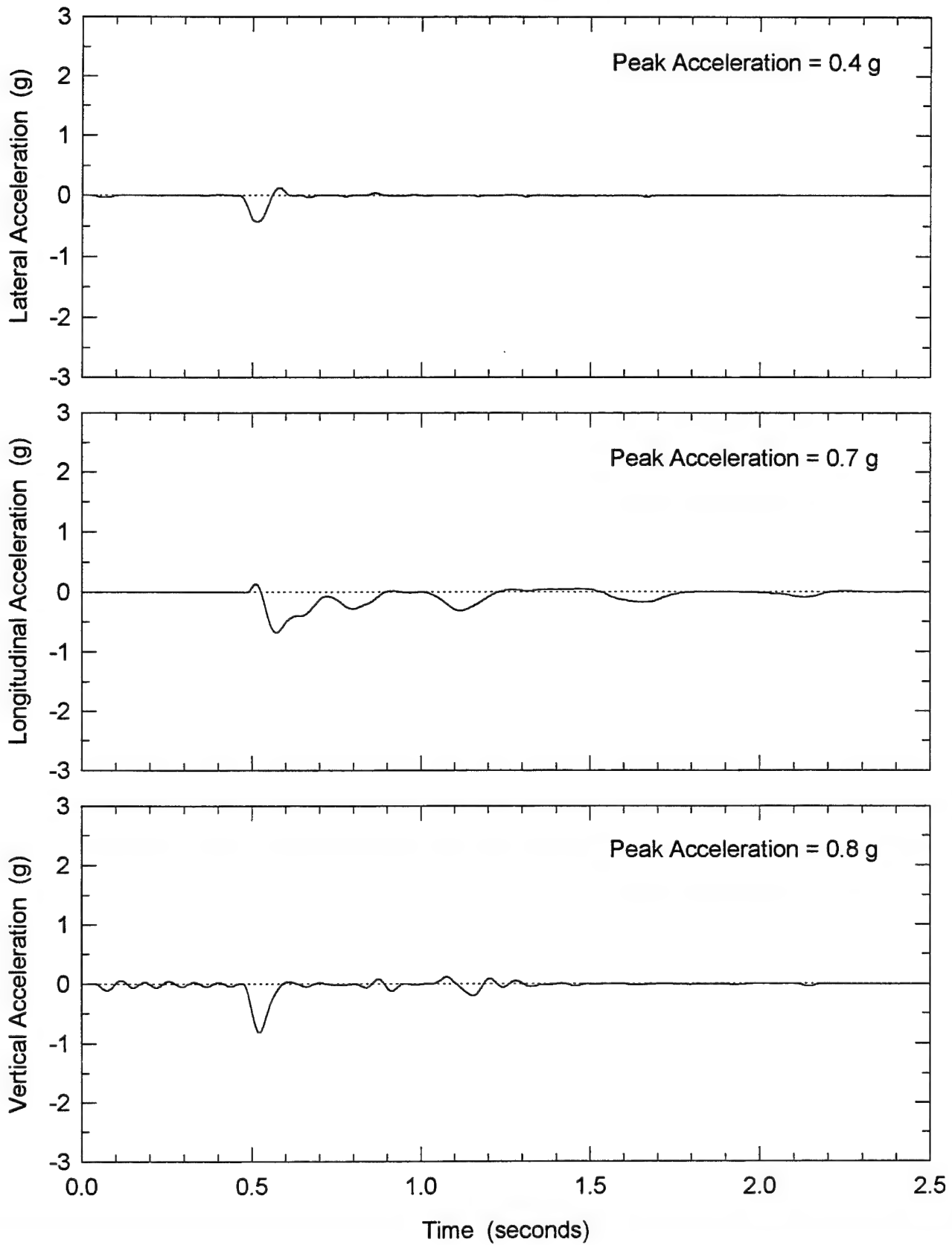
Pallet on Trailer

Coupling Speed = 8.9 mph



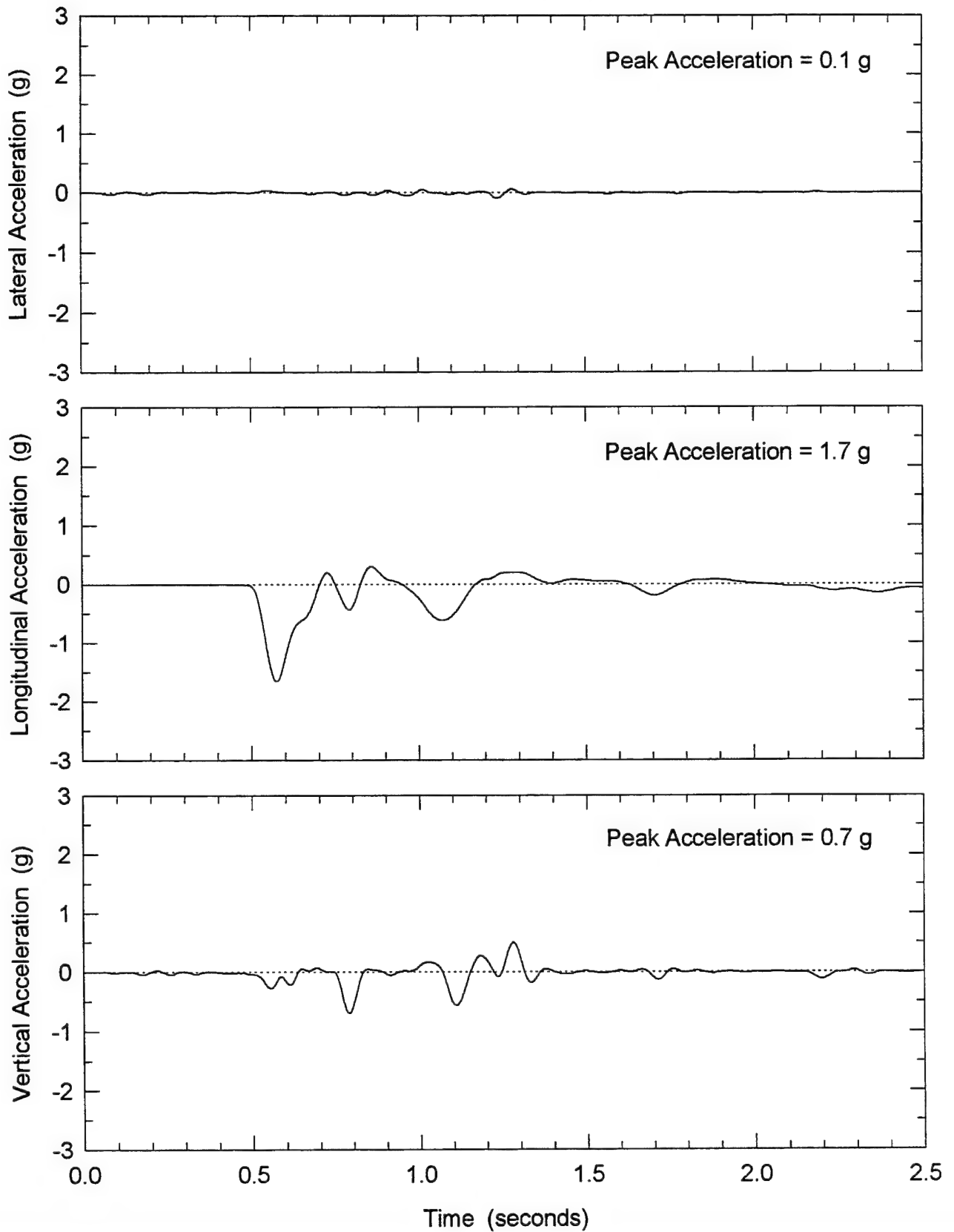
Pallet on Six-Axle Truck

Coupling Speed = 4.5 mph



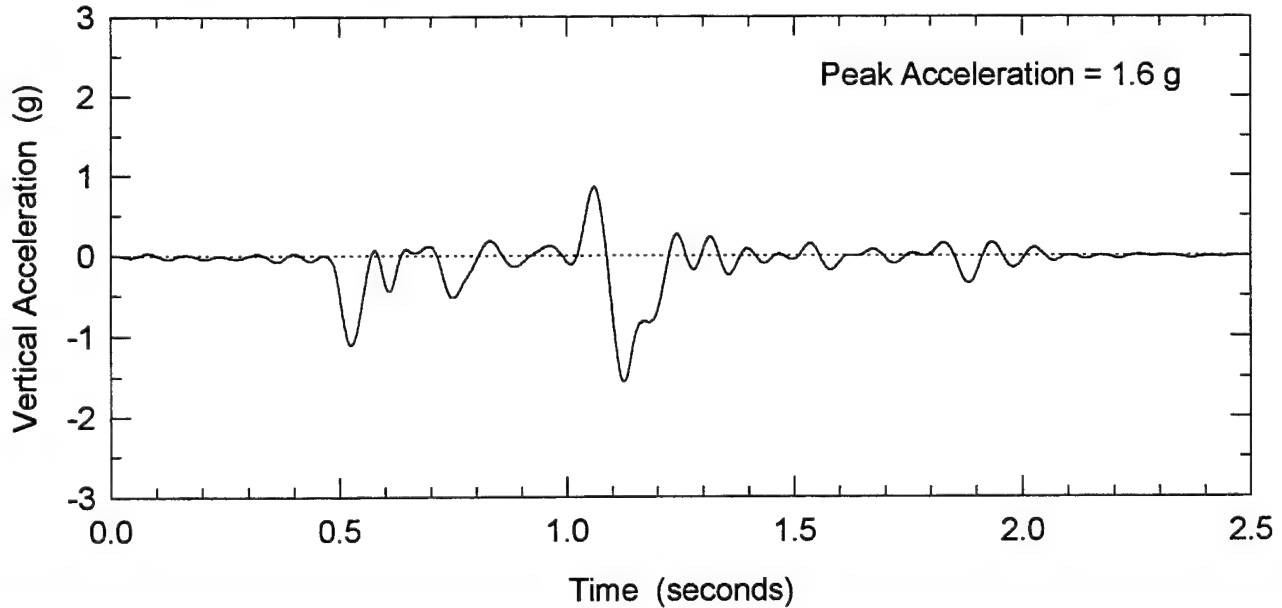
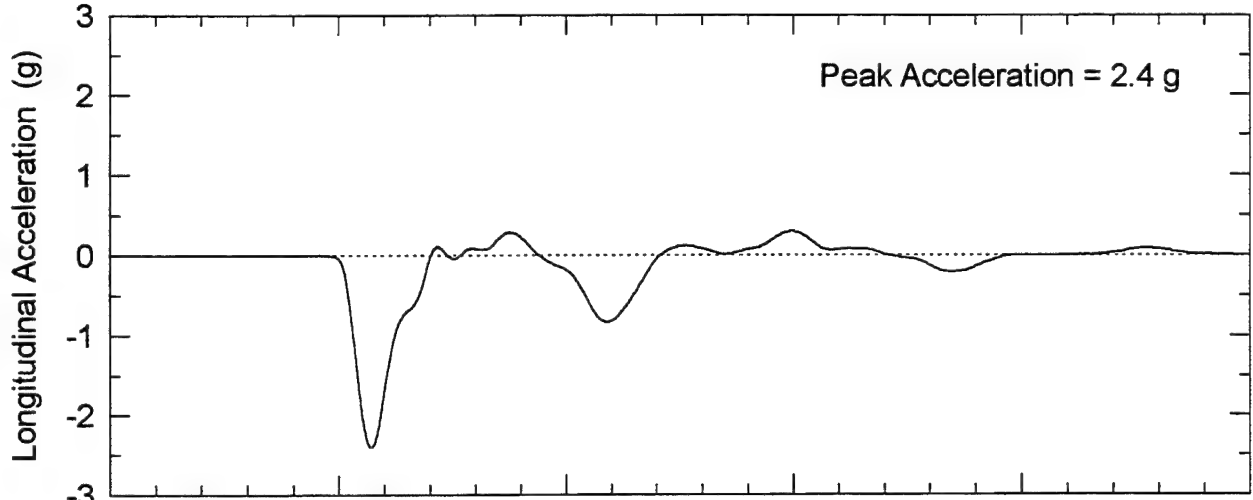
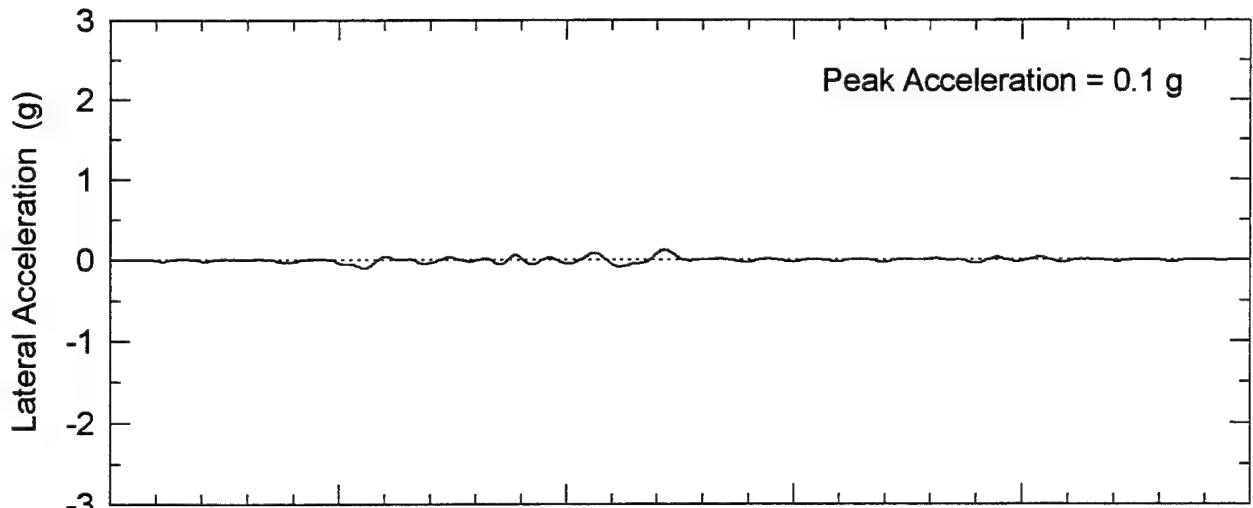
Pallet on Six-Axle Truck

Coupling Speed = 6.2 mph



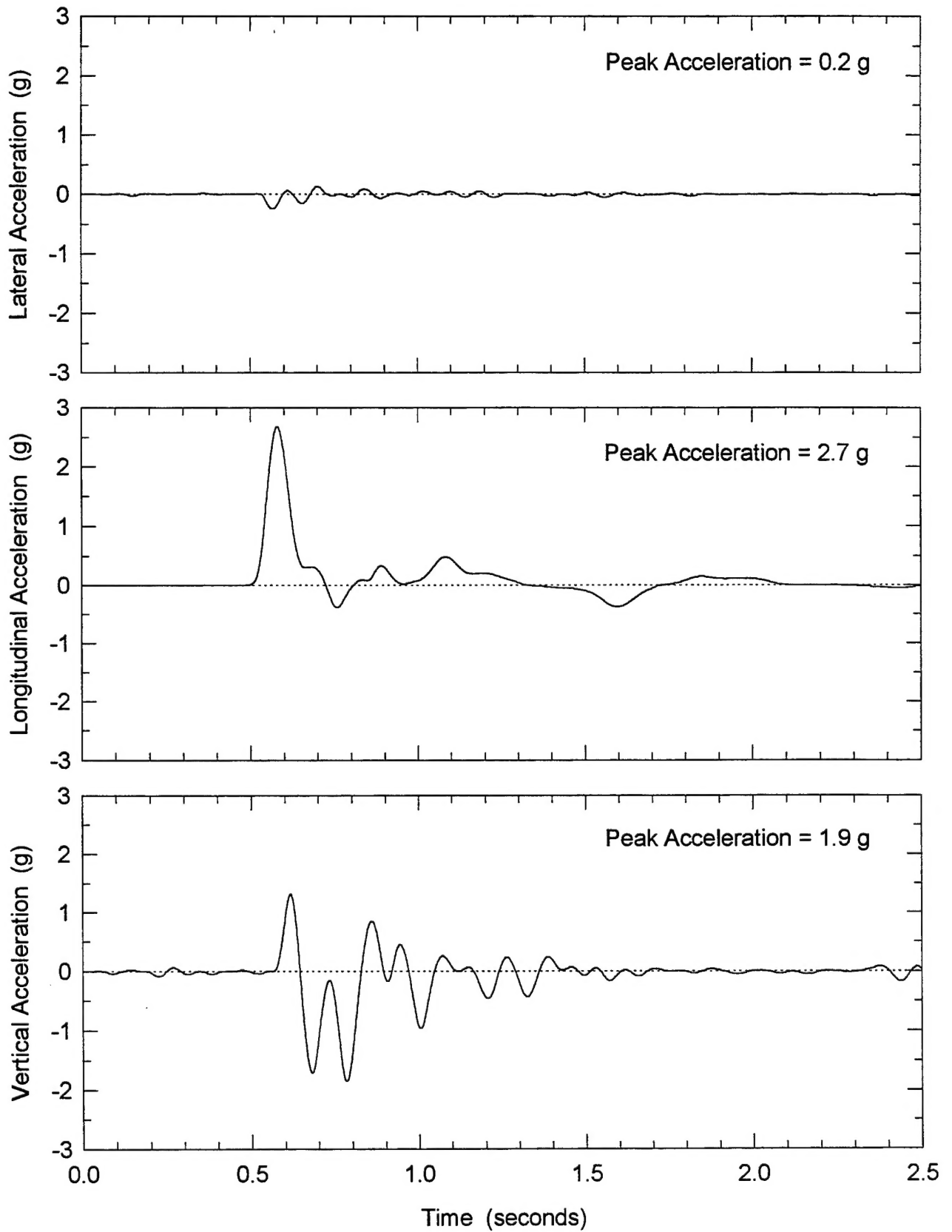
Pallet on Six-Axle Truck

Coupling Speed = 8.5 mph



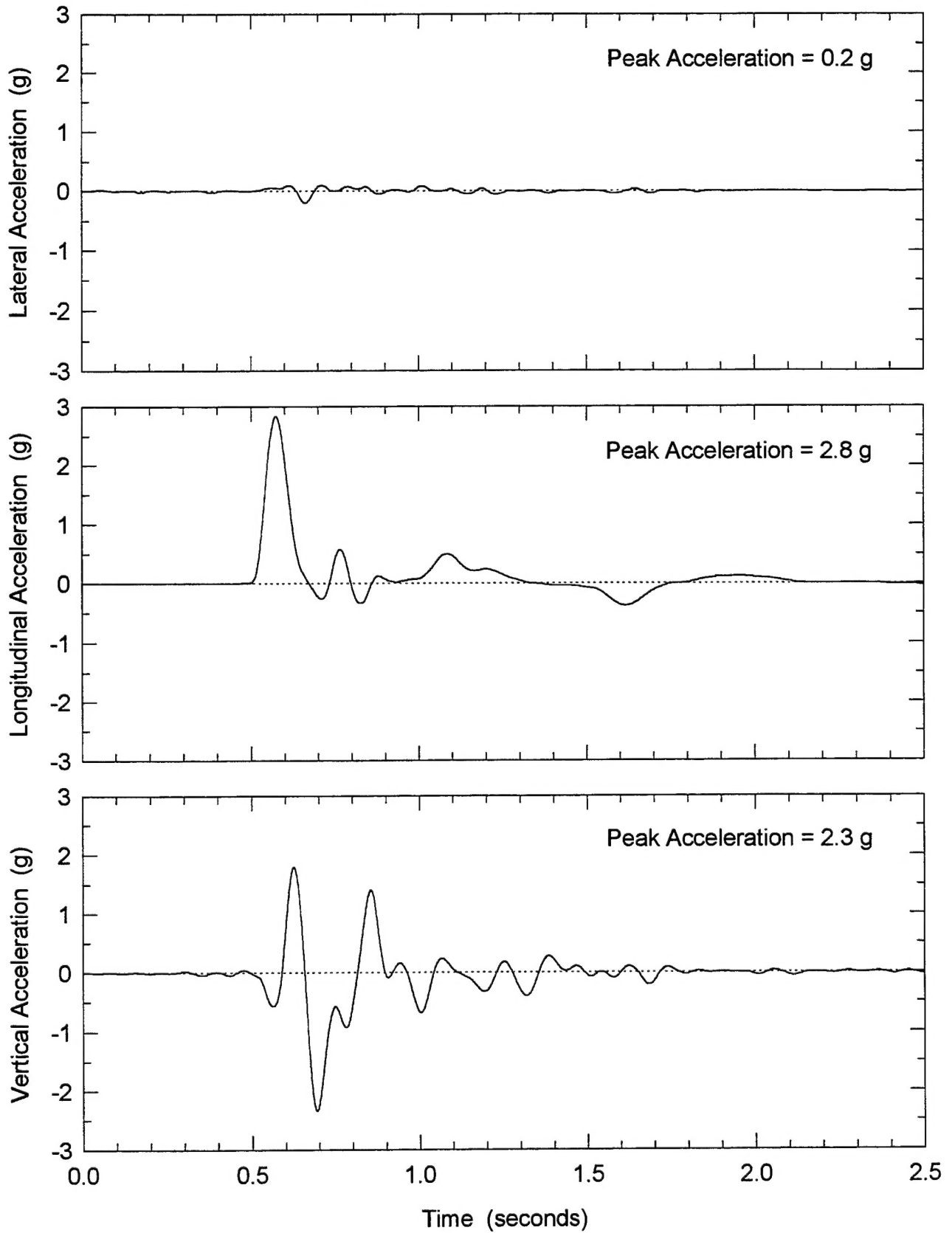
Pallet on Six-Axle Truck

Coupling Speed = 8.0 mph



Pallet on Six-Axle Truck

Coupling Speed = 8.3 mph



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**Pages including this
cover page:** 11

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March 4, 1996

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Al:

Enclosed are graphs and ASCII disk files of the acceleration wave forms recorded during last week's impact tests. The text file "READ.ME" describes the files.

Our EDR-3s have 60 Hz, 4-pole analog input filters to prevent aliasing. Sampling rate was 1 kHz. During analysis, I applied 10 Hz, 4-pole, Butterworth filters to the data.

The longitudinal accelerations look normal for this type of car. They should accurately describe inputs to the load. This is not true for the lateral and vertical wave forms since the EDR-3 was mounted at the end of the car, far from the load, and flat cars flex considerably during impacts. In the vicinity of the load, I would expect the lateral acceleration to be negligible. The vertical acceleration should be a nearly pure sine wave that damps out in a few seconds.

Kendahl